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1. Your Reference	P.7280 GBA
2. Patent application number *(The Patent Office will fill in this part)*	0329802.3
3. Full name, address and postcode of the or of each applicant *(underline all surnames)*	HOWES, Jonathan Sebastian 3 Chapel Cottages Cowfold Road Bolney West Sussex RH17 5QU G.B. MACNAGHTEN, James Fernleigh Cottage 3 Hill Avenue Cambridge CB1 7UY G.B.
Patents ADP number *(if you know it)*	08329757001. / 08778045001
If the applicant is a corporate body, give the country/state of its incorporation	
4. Title of the invention	SAILING VESSEL
5. Name of your agent *(if you have one)* "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	MAGUIRE BOSS 5 Crown Street St. Ives Cambridgeshire PE27 5EB, G.B.
Patents ADP number *(if you know it)*	07188725001 ✓

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b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body:)
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Continuation sheets of this form	
Description	8
Claims(s)	2
Abstract	5
Drawing(s)	4

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Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature(s) Maguire Boss Date: 23.12.03

MAGUIRE BOSS

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

P.J. EVENS Tel: 01480 301588
e-Mail: patents@maguires.co.uk

Warning

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TITLE: SAILING VESSEL

DESCRIPTION

The present invention relates generally to a sailing vessel, and more specifically to a sailing vessel comprising a novel keel.

Fin keels (e.g. comprising a single fin supporting a ballast bulb) are well known in the art as a means of providing lateral stability to conventional sailing vessels. However, there are a number of problems associated with fin keels. For example, fin keels are structurally vulnerable to impacts and dynamic loads, with flexure of a fin keel having the potential to cause substantial damage thereto, particularly if cyclically applied loads (e.g. due to waves) are close to the natural frequency of the keel. Furthermore, efficient fin keels require a deep draught to ensure an adequate lifting efficiency. High aspect ratio fins suffer from a low stalling angle which can lead to control problems in rough

conditions, and in the worst cases can lead to regular loss of control of a vessel. In contrast, shorter (i.e. shallow draught) keels may be strong, but deliver poor upwind performance due to increased vortex drag.

A common solution to the problems relating to fin keels is to use a twin keel arrangement in which two, shallow-draught fin keels are used instead one deep draft keel. Generally, the two keels are splayed outwards to provide a small amount of "toe in" such that when a vessel is healed, the leeward keel becomes more upright and is angled to best resist leeway. However, once in this orientation, the weather keel acts to increase heel, and both keels will produce substantial vortex drag. Although it is possible to design a hull for a twin keel arrangement such that the weather keel generates reduced force with increased heel, this is generally at the cost of hull performance. Furthermore, when sailing upright (e.g. downwind), both keels produce a counter rotating vortex pair which also carries a signification drag penalty.

Accordingly, the present applicants have identified the need for a sailing vessel having an improved keel which overcomes, or at least alleviates, the problems associated with conventional keel arrangements.

In accordance with the present invention there is provided a sailing vessel comprising a hull means and a keel comprising a member depending from the hull means, characterised in that the member comprises two limbs each depending from a respective lateral side of the hull means,

the two limbs defining at least in part an enclosed flow path extending through the keel in a bow to stern direction, the enclosed flow path being configured for allowing water incident on the keel to flow therethrough when sailing the sailing vessel.

In this way, a keel with an enclosed flow path (or "loop keel" defining a "loop") is provided which, when in use, may result in a closed loop of hydrodynamic force, all directed away from the centre of the enclosed closed flow path. This situation is analogous to a vortex ring in a continuous flow and, unless an overall lateral force is being generated on the loop keel, should not result in substantial vorticity being shed by the loop keel. The hull means may be a monohull.

The two limbs of the loop keel may be connected together direct or, for example, via a ballast bulb. The limbs of the looped keel member may have a cross-section similar to a conventional fin keel.

The two limbs may each comprise a substantially straight portion. For example, the member may comprise a pair of substantially straight limbs connected together to form a V-shape (when viewed from the bow or stern of the sailing vessel) with a portion of the hull means completing the loop to form the enclosed flow path. The limbs may be angled so as to generate a continuous outward force all around the loop.

The two limbs may be symmetrically disposed on either side of a central, longitudinal axis of the hull means.

The loop keel may be similarly symmetrical.

For improved hydrodynamic performance, the two limbs may be directed (e.g. curved) inwards toward the hull means where they depend from the hull means. For example, the two limbs may be substantially perpendicular to the hull means at the point where they meet the hull means, with the objective of minimising interference drag between the loop keel and the hull means.

The keel may further comprise a ballast portion. For example, the loop keel may comprise a ballast bulb disposed at a lowest part of the keel (e.g. at the apex of a V-shaped loop keel). Alternatively, or in addition, the loop keel may further comprise a substantially planar, horizontal element disposed at a lowest part of the loop keel member, and containing ballast. The substantially planar surface may be configured to support the sailing vessel when grounded, e.g. between tides. At the base of the loop keel, the two limbs may be angled (e.g. curved) to smoothly meet the ballast bulb.

The limbs of the looped keel member may have a cross-section similar to a conventional fin keel.

An embodiments of the present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows a schematic perspective view of an underside of a sailing vessel embodying the present invention;

Figure 2 shows a force diagram representing the

vortex ring produced by the loop keel of the sailing vessel shown in Figure 1;

Figure 3 shows a split schematic front/rear view of the sailing vessel of Figure 1;

Figure 4A shows a schematic side view of the sailing vessel of Figure 1;

Figure 4B shows a schematic plan view of one half of the sailing vessel of Figure 1;

Figure 5 shows the sailing vessel of Figure 1 compared with a conventional fin keel sailing vessel in a heeling position; and

Figure 6 shows a schematic representation of the sailing vessel of Figure 1 and the convention single heel sailing vessel of Figure 5 in a cross-flow.

Figures 1, 3, 4A and 4B show a sailing vessel 10 comprising a hull 20 and a loop keel 30, the loop keel 30 comprising a substantially V-shaped looped keel member 34 attached to the hull 20 at two laterally spaced locations 38,39. The looped keel member 34 comprises a pair of limbs 44, each having substantially straight fin-like portions 45 which are attached at one end to a central ballast bulb 42, and curved, upper portions 46 which attach the loop keel to the hull 20 at the two laterally spaced locations 38,39. The pair of limbs 44 in combination with the hull 20, form an enclosed flow path (a "loop" or aperture) 40 through which water may pass.

The surfaces of the loop keel 30 are angled so as to generate a continuous outwards force all around the loop

(this is directly equivalent to a vortex ring in a continuous flow). Figure 2 shows schematically the equivalent vortex ring produced by the loop keel 30 when zero overall lateral force is applied thereto.

Figure 5 shows various forces acting on the sailing vessel 10 in a heeled position as compared with the forces acting on a conventional sailing vessel 50 comprising a fin keel 52. Whereas all the dynamic forces shown acting on the fin keel 52 act to increase the heeling moment, all of the dynamic forces shown acting on the loop keel 30 act to reduce the heeling moment. The ballast effect for both keels is similar.

Figure 6 shows the conventional fin keel 52 and the loop keel 30 in a cross flow. With a conventional fin keel, any cross-flow results in a sudden increase in incidence. In contrast, cross-flow results in flow along the limbs 44. When coupled with fore and aft flow, this acts to reduce the local incidence change, and thereby provides improved stall resistance.

The advantages of the present invention may be explained as follows. When the rig of the sailing vessel is loaded, the effect is to both load the loop keel laterally to resist the rig load and to generate a heeling moment to leeward. The effect of this on the loop keel is to cause the weather limb of the loop keel to become more upright and also, depending on the particular design, to break the water surface and thus disturb the equivalent vortex ring of the unloaded keel. As this limb is angled

to generate force away from the centre of the loop, it is ideally placed to generate an efficient leeway resisting force, this force is also generated without requiring the hull to crab as with a conventional fixed fin and this can be used to reduce the heeled hull drag. It also has a further advantage over a fin keel in this condition, since the other limb of the keel (the leeward limb) still provides surface continuity and acts in the same manner as an aircraft winglet increasing the effective aspect ratio of the keel and thus reducing the vortex drag. The leeward limb generates a force both downward and to a lesser degree to leeward. The hull, due to the heeling angle, also moves the centre of buoyancy to leeward (form stability) and the force from the leeward keel limb is offset from the centre of buoyancy to weather, this results in a dynamic righting moment. The overall result is that a loop keel equipped yacht should sail to windward with less drag and less heel than a similar yacht equipped with a fin keel.

Yet a further advantage of the loop keel is that the limbs of the keel will always offer some element of the working keel surface to the water flow at a lateral angle, which will tend to cause a degree of cross flow which has the effect of increasing resistance to stalling. The keel will thus generate lift to high angles of attack and be highly resistant to stall in rough conditions. The loop keel is also of a naturally sturdy and stiff structural form and is very unlikely to suffer from elastically induced dynamic overloads.

If two otherwise similar sailing vessels are equipped with a fin keel and a competing loop keel of similar draught, the loop keeled vessel will sail downwind with a similar performance to the fin-keeled vessel. However, as soon as the course is such as to place a lateral load on the keel, the loop keeled vessel will said faster, with less heel and thus a correspondingly more efficient rig, and will be more controllably in extreme conditions. It will also be significantly stronger. If the performance of the two vessels is matched, the loop keeled vessel will have a lower draught than the fin keeled vessel; this reduction in draught is likely to be of the order of 20% to 30%.

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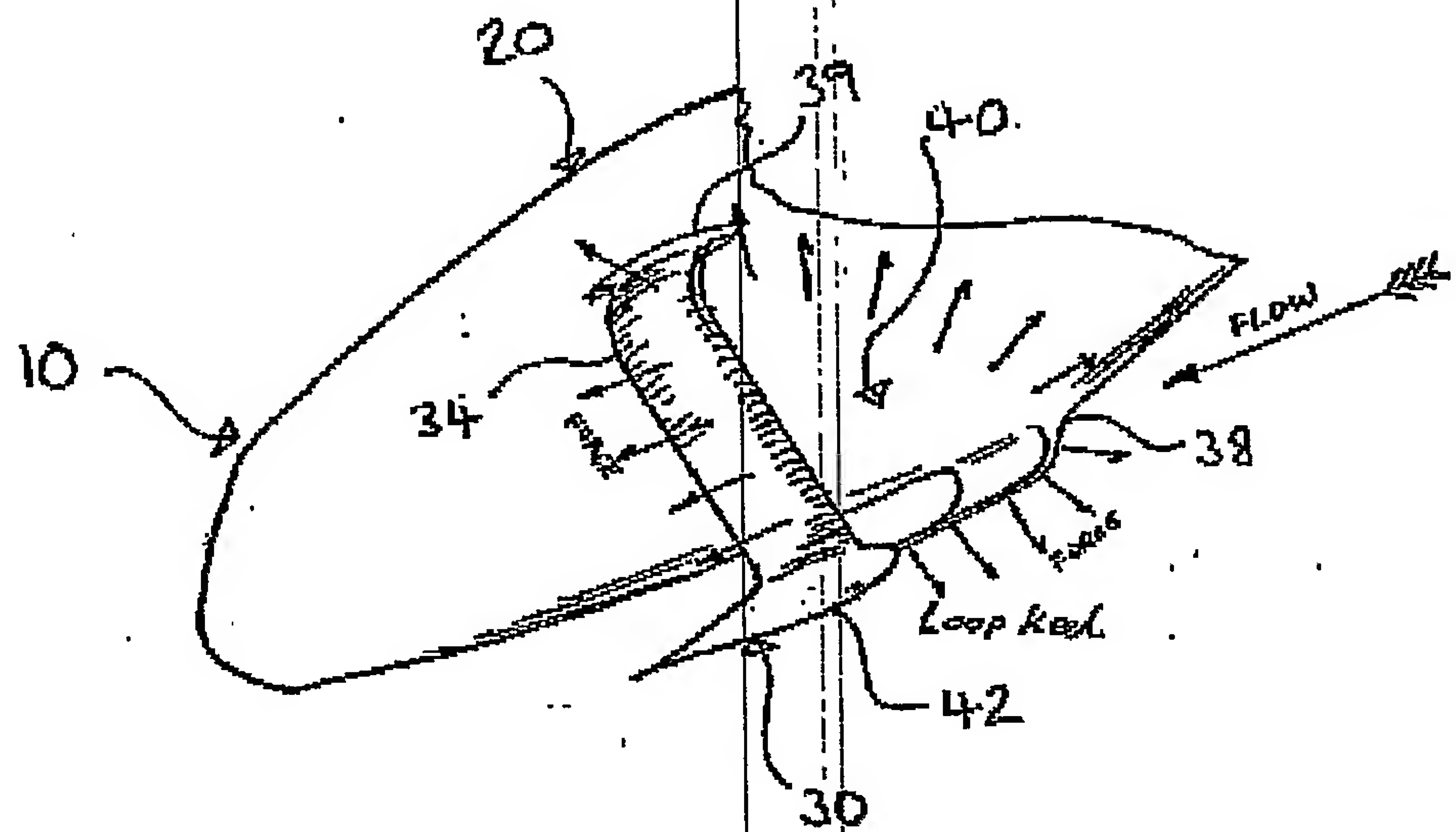

FIGURE 1

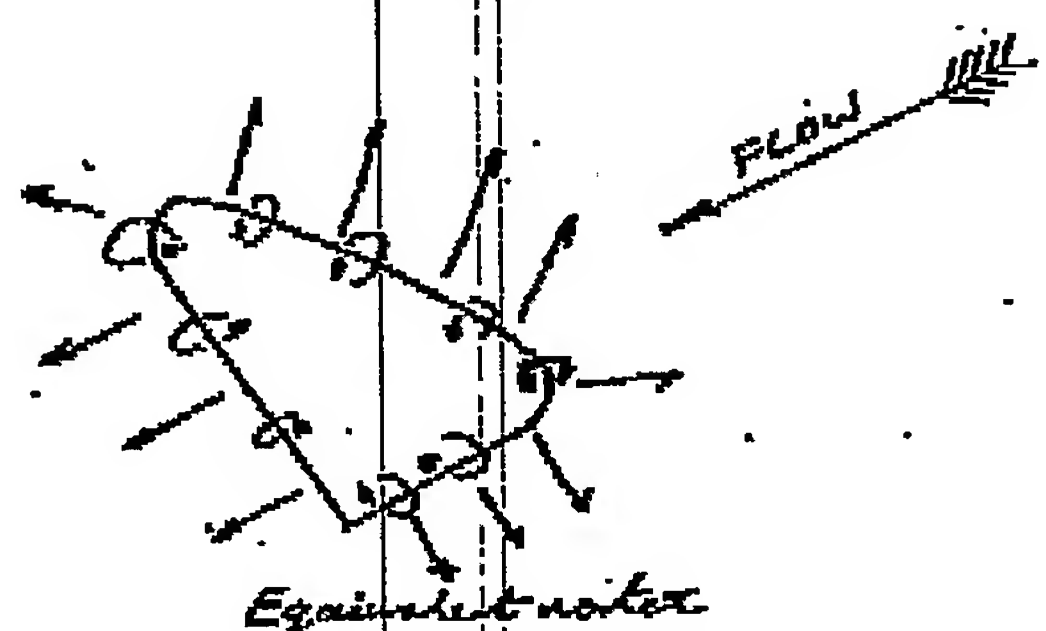

FIGURE 2

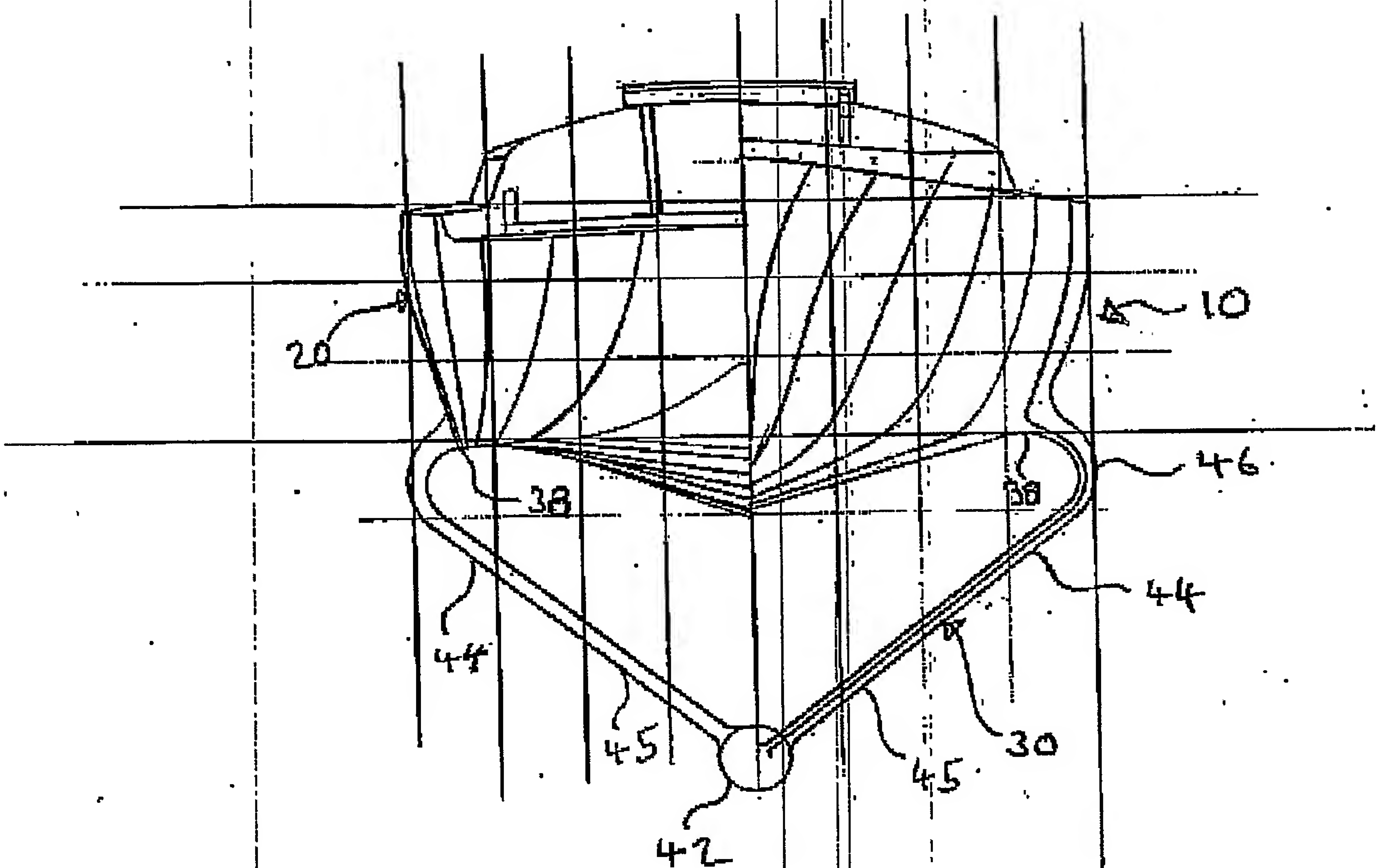

FIGURE 3

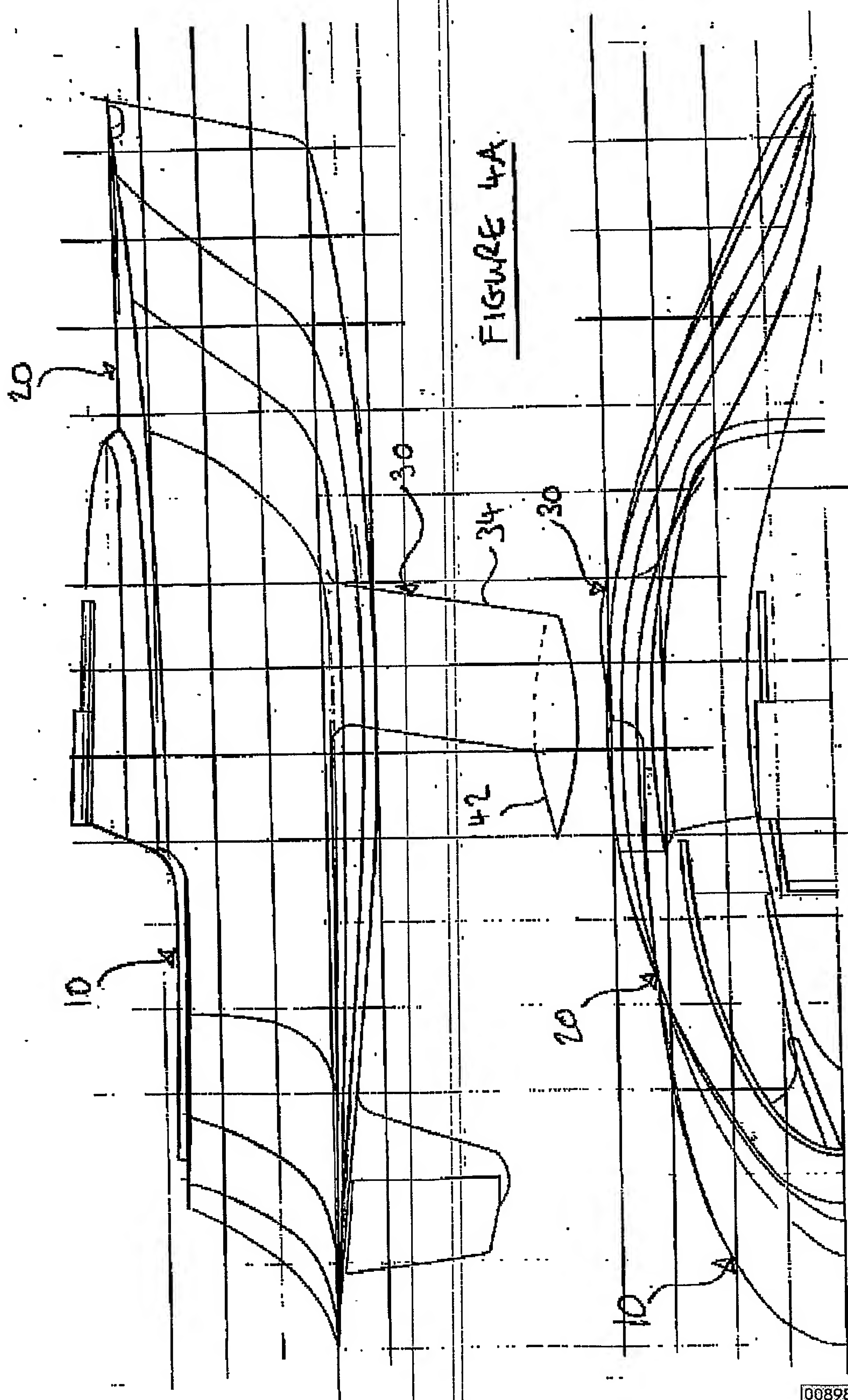

FIGURE 4A

FIGURE 4B

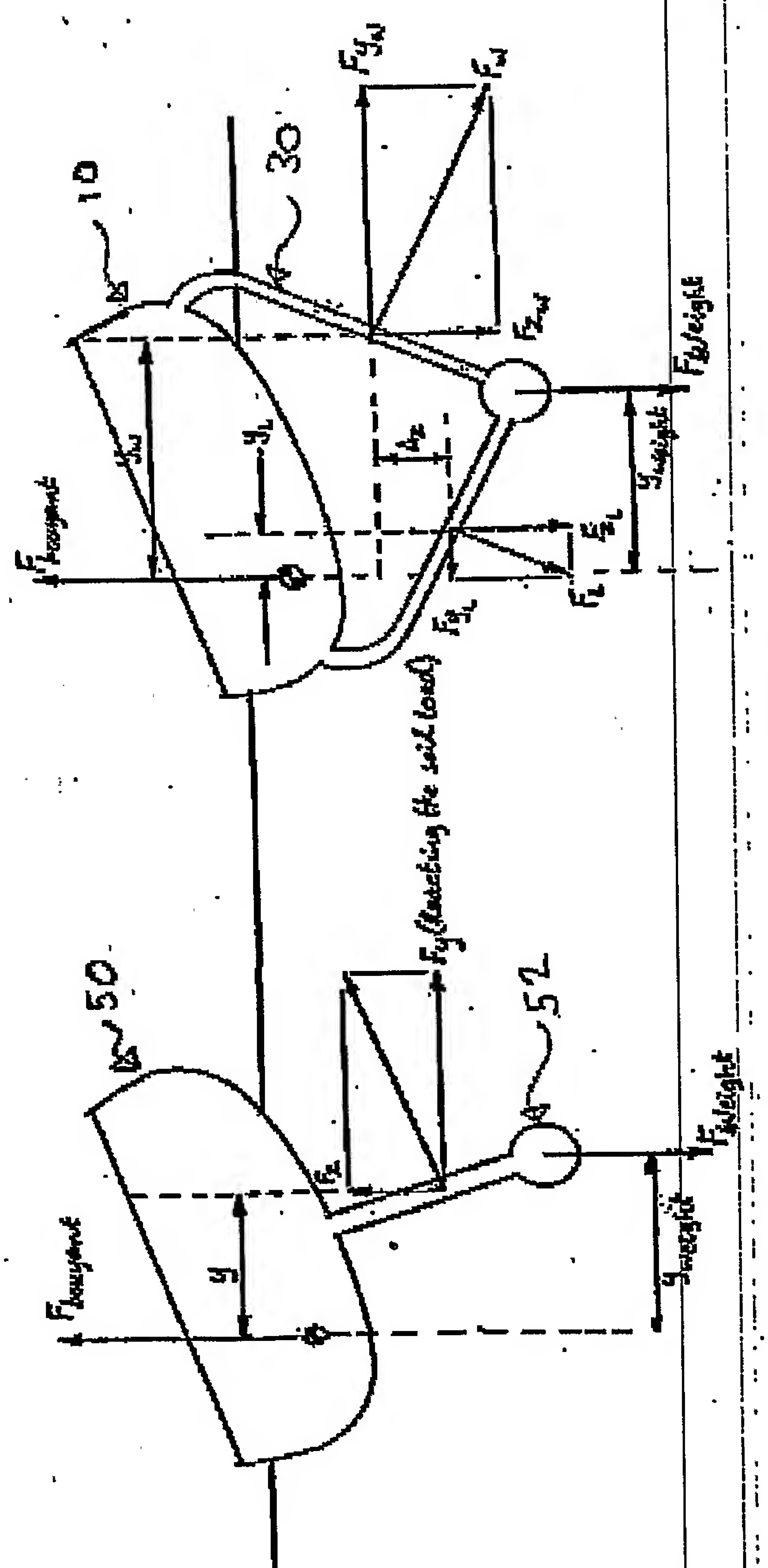

FIGURE 5

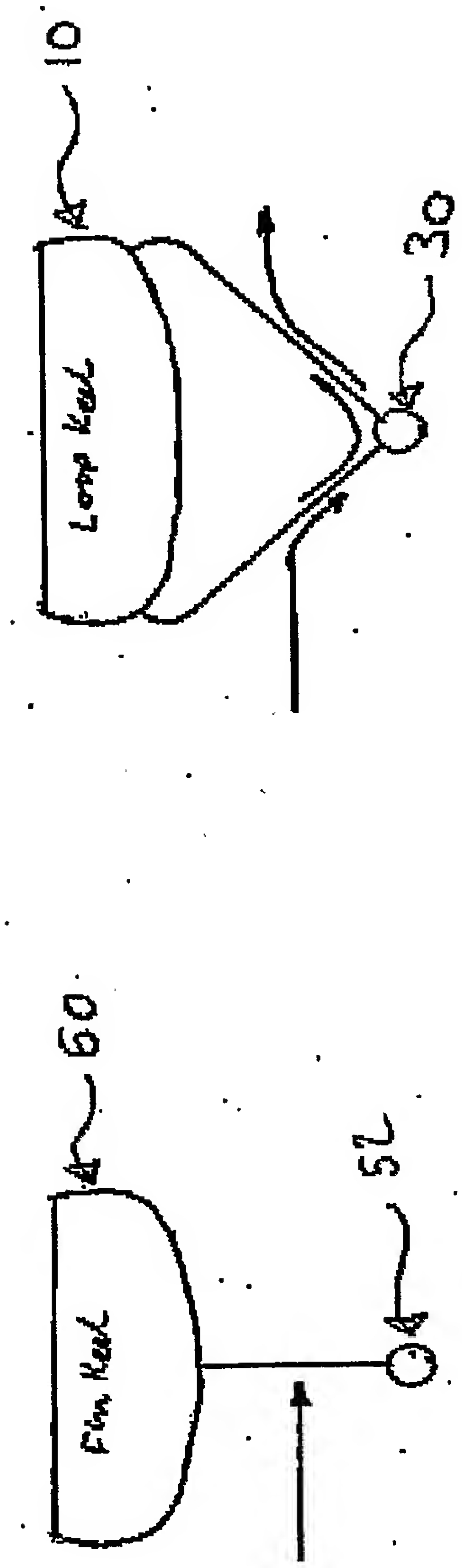

FIGURE 6

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1. Your Reference	P.7280 GBA	
2. Patent application number *(The Patent Office will fill in this part)*	0329802.3	
3. Full name, address and postcode of the or of each applicant *(underline all surnames)*	HOWES, Jonathan Sebastian 3 Chapel Cottages Cowfold Road Bolney West Sussex RH17 5QU G.B.	MACNAGHTEN, James Fernleigh Cottage 3 Hill Avenue Cambridge CB1 7UY G.B.
Patents ADP number *(if you know it)*	08329757001.	08778045001
If the applicant is a corporate body, give the country/state of its incorporation		
4. Title of the invention	SAILING VESSEL	
5. Name of your agent *(if you have one)* "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	MAGUIRE BOSS 5 Crown Street St. Ives Cambridgeshire PE27 5EB, G.B.	
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Signature(s) Maguire Boss

MAGUIRE BOSS

Date: 23.12.03

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom	**P.J. EVENS**	Tel: 01480 301588 e-Mail: patents@maguires.co.uk

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A common solution to the problems relating to fin keels is to use a twin keel arrangement in which two, shallow-draught fin keels are used instead one deep draft keel. Generally, the two keels are splayed outwards to provide a small amount of "toe in" such that when a vessel is healed, the leeward keel becomes more upright and is angled to best resist leeway. However, once in this orientation, the weather keel acts to increase heel, and both keels will produce substantial vortex drag. Although it is possible to design a hull for a twin keel arrangement such that the weather keel generates reduced force with increased heel, this is generally at the cost of hull performance. Furthermore, when sailing upright (e.g. downwind), both keels produce a counter rotating vortex pair which also carries a signification drag penalty.

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In this way, a keel with an enclosed flow path (or "loop keel" defining a "loop") is provided which, when in use, may result in a closed loop of hydrodynamic force, all directed away from the centre of the enclosed closed flow path. This situation is analogous to a vortex ring in a continuous flow and, unless an overall lateral force is being generated on the loop keel, should not result in substantial vorticity being shed by the loop keel. The hull means may be a monohull.

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The advantages of the present invention may be explained as follows. When the rig of the sailing vessel is loaded, the effect is to both load the loop keel laterally to resist the rig load and to generate a heeling moment to leeward. The effect of this on the loop keel is to cause the weather limb of the loop keel to become more upright and also, depending on the particular design, to break the water surface and thus disturb the equivalent vortex ring of the unloaded keel. As this limb is angled

to generate force away from the centre of the loop, it is ideally placed to generate an efficient leeway resisting force, this force is also generated without requiring the hull to crab as with a conventional fixed fin and this can be used to reduce the heeled hull drag. It also has a further advantage over a fin keel in this condition, since the other limb of the keel (the leeward limb) still provides surface continuity and acts in the same manner as an aircraft winglet increasing the effective aspect ratio of the keel and thus reducing the vortex drag. The leeward limb generates a force both downward and to a lesser degree to leeward. The hull, due to the heeling angle, also moves the centre of buoyancy to leeward (form stability) and the force from the leeward keel limb is offset from the centre of buoyancy to weather, this results in a dynamic righting moment. The overall result is that a loop keel equipped yacht should sail to windward with less drag and less heel than a similar yacht equipped with a fin keel.

Yet a further advantage of the loop keel is that the limbs of the keel will always offer some element of the working keel surface to the water flow at a lateral angle, which will tend to cause a degree of cross flow which has the effect of increasing resistance to stalling. The keel will thus generate lift to high angles of attack and be highly resistant to stall in rough conditions. The loop keel is also of a naturally sturdy and stiff structural form and is very unlikely to suffer from elastically induced dynamic overloads.

If two otherwise similar sailing vessels are equipped with a fin keel and a competing loop keel of similar draught, the loop keeled vessel will sail downwind with a similar performance to the fin-keeled vessel. However, as soon as the course is such as to place a lateral load on the keel, the loop keeled vessel will said faster, with less heel and thus a correspondingly more efficient rig, and will be more controllably in extreme conditions. It will also be significantly stronger. If the performance of the two vessels is matched, the loop keeled vessel will have a lower draught than the fin keeled vessel; this reduction in draught is likely to be of the order of 20% to 30%.

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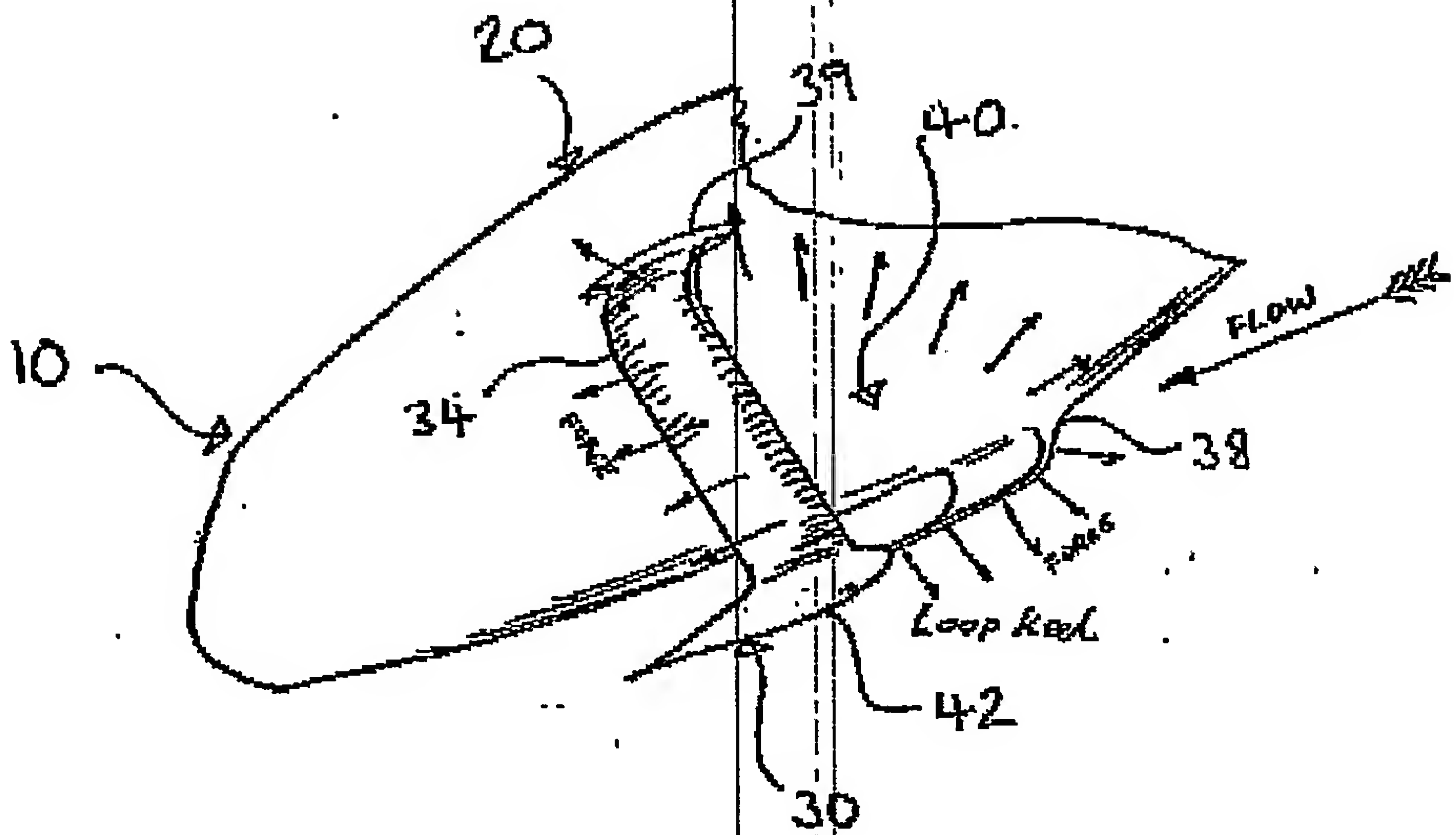

FIGURE 1

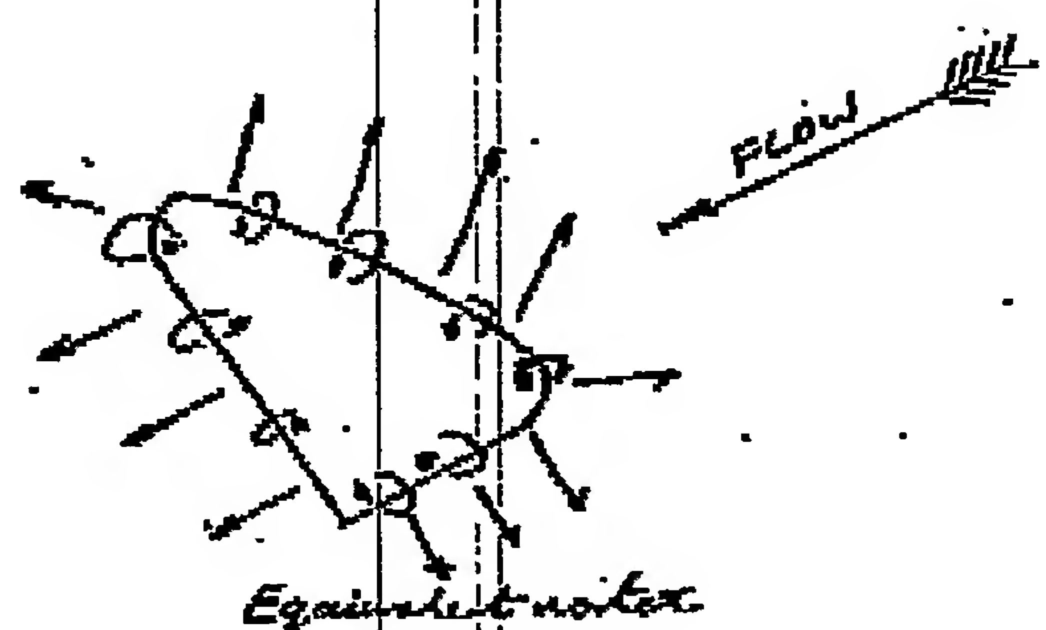

FIGURE 2

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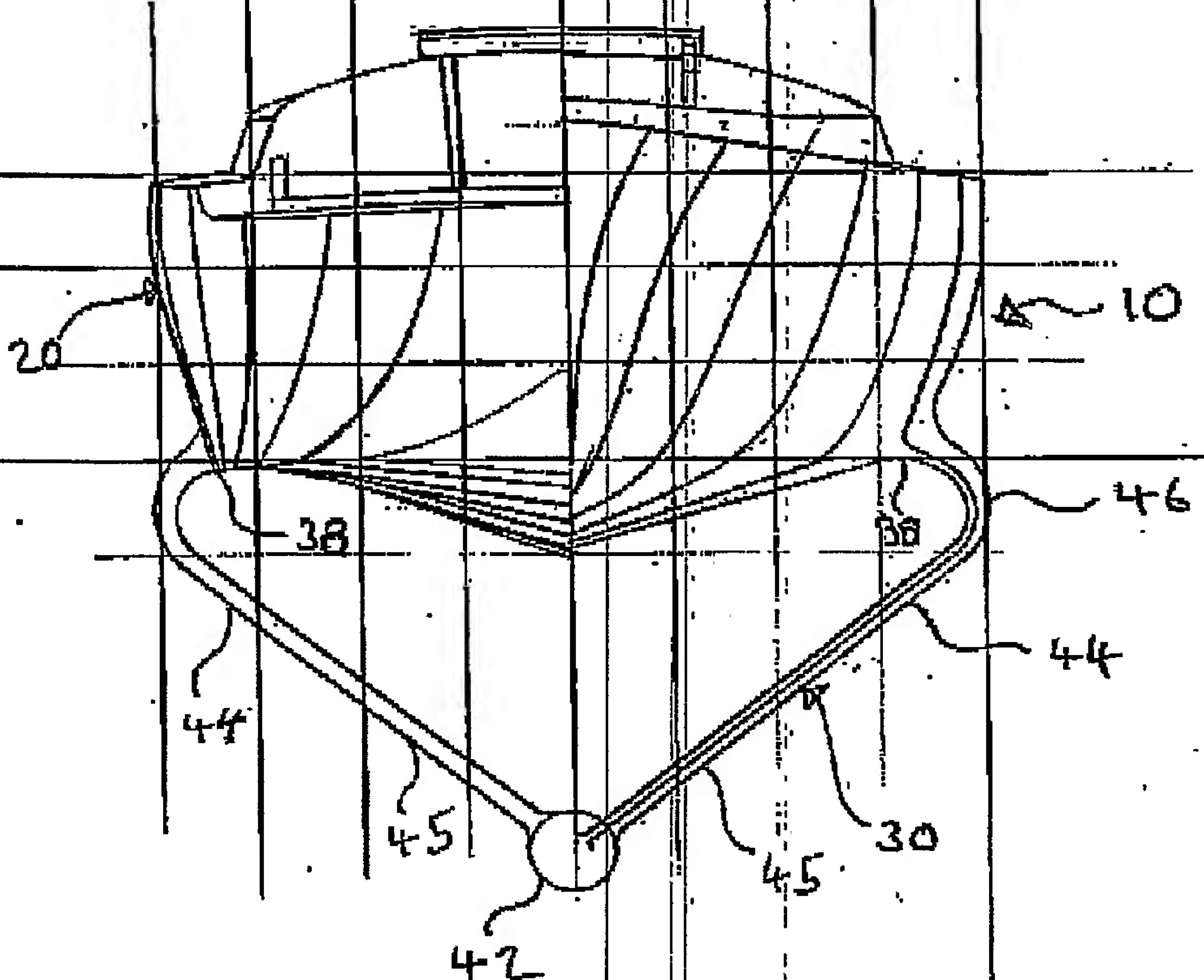

FIGURE 3

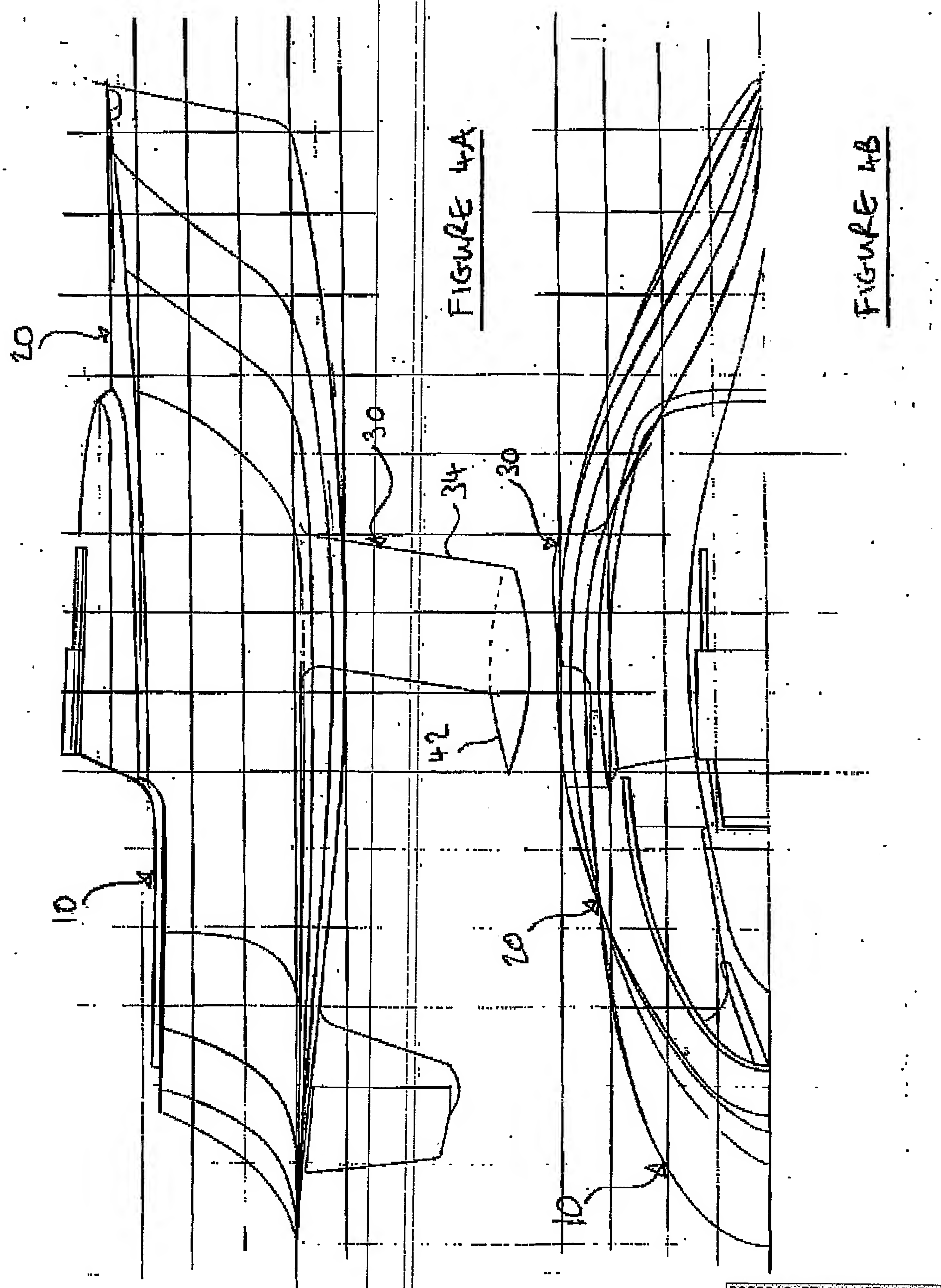

FIGURE 4A

FIGURE 4B

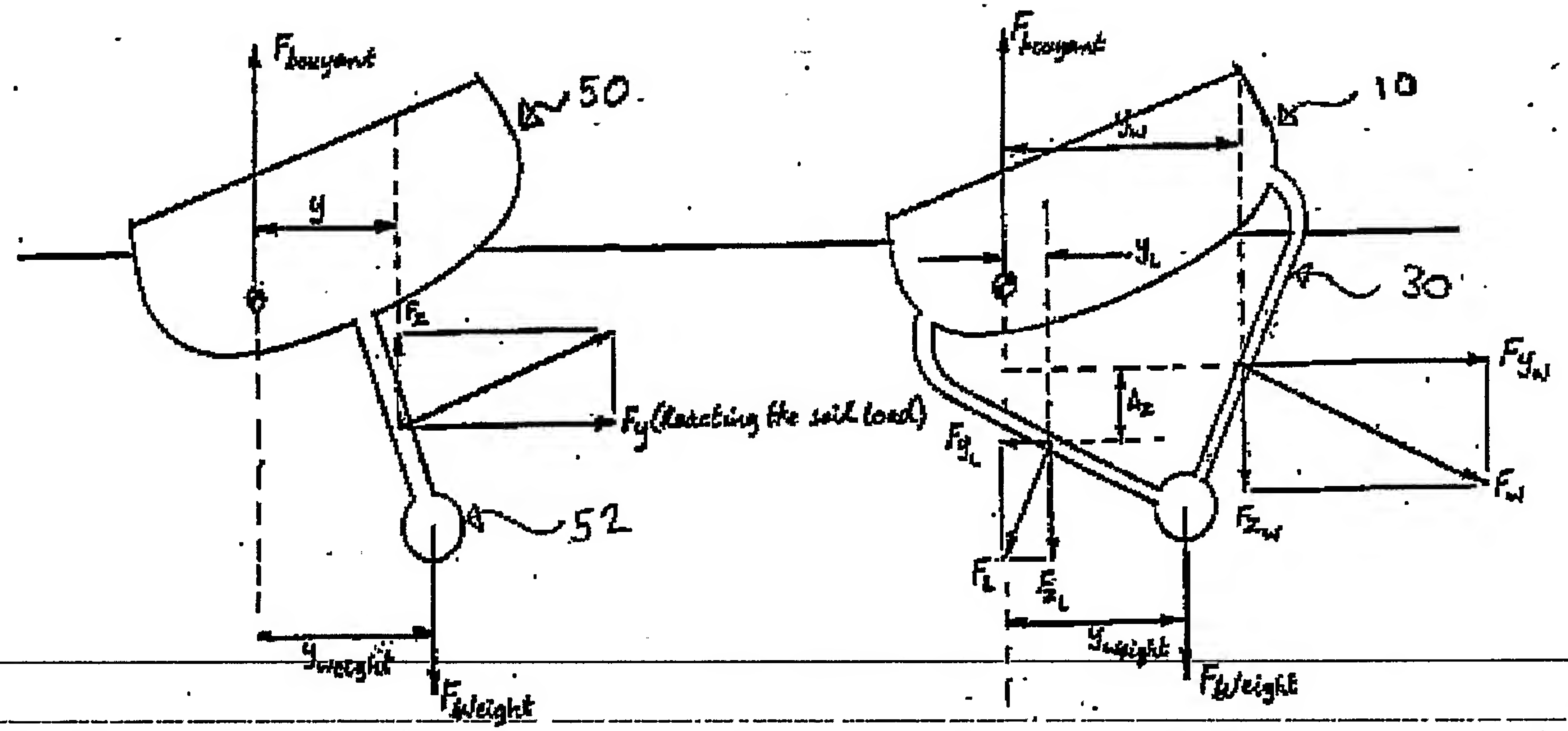

FIGURE 5

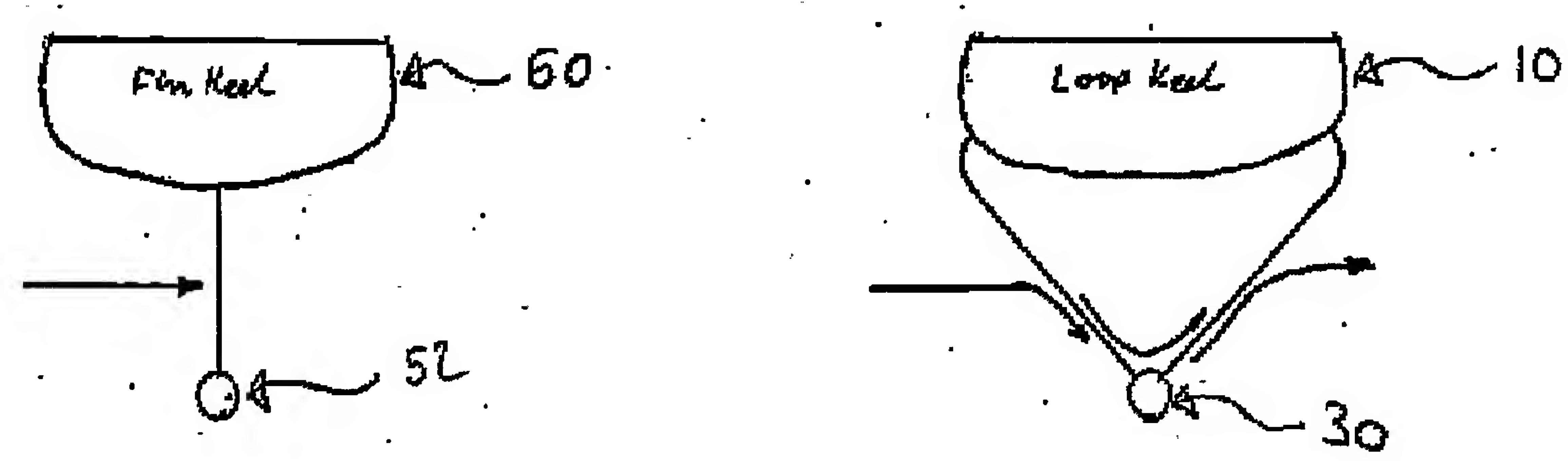

FIGURE 6